

REMARKS

This Preliminary Amendment presents a Substitute Specification, an amended Abstract, and new claims.

A marked-up version of the Substitute Specification, showing additions to the translation by underlining and deletions from the translation by strike-through, is attached a Appendix III. The Substitute Specification includes no new matter.

Please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket # 095309.57220US).

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APPENDIX

II

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Abstract

ABSTRACT OF THE DISCLOSURE

The invention relates to a A tube bend [[1 with]] has at least one bend zone [[1.1]] and two outlet zones 1.2, 1.3 adjoining the latter on both sides. In this connection, the The tube bend [[1]] has a different cross-sectional shape from the outlet zones 1.2, 1.3 with an identical flow cross section 1.4. In this connection, the The degree of expansion, as the ratio of the diameter of the component in the bending plane to the diameter of the blank in the bending plane, has a value between 1 and 1.1.

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APPENDIX

III

Tube bendTUBE BEND

The present invention relates to a tube piece designed
5 as a tube bend, with at least one bend zone and two
outlet zones adjoining the latter on both sides with in
each case an end side for the application of pushing
rams of an internal high-pressure tool which comprises
10 a die with a recess forming the production cross
section.

A method for manufacturing a tube bend is already known
from German document DE 43 22 711 C2. There, the tube
section is bent before internal high-pressure forming
15 and upset axially during the internal high-pressure
forming. In the process, the tube section undergoes
enlargement of the average diameter, this expansion
taking place over the entire periphery relative to the
central axis. Starting from a round tube cross section
20 and taking the ovality of the cross section in the
region of the tube bend brought about during bending
into account, the requisite degree of expansion is
greater in this region of the tube section in relation
to the average degree of expansion.

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The invention ~~is based on~~ has as an object the object
of designing and arranging a tube bend in such a way
that stable cross-sectional enlargement is guaranteed
during internal high-pressure forming.

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According to the invention, [[the]] this object is
achieved by virtue of the fact that the bend zone has a
different cross-sectional shape from the outlet zones

with an approximately identical flow cross section. The result of this is that the different cross-sectional shape guarantees loading of the tube bend and at the same time a throttling effect of the bend zone is 5 prevented owing to the constant flow cross section.

The axial pushing force exerted on the tube bend during manufacture of this internal high-pressure formed part serves, by virtue of the changed cross-sectional shape 10 in the bend zone, to support the material flow, the changed cross-sectional shape preventing a buckling movement of the tube bend.

~~For this, it~~ It is advantageous if the internal high-pressure tool for manufacturing a tube piece comprises a die with a recess forming the production cross section of the tube bend, the recess having at least one bend zone and two outlet zones adjoining the latter on both sides. In this connection, the recess of the 20 die has a different cross-sectional shape from the outlet zones with an identical cross-sectional area which forms the production cross section. The recess thus formed, or the internal high-pressure tool thus formed, guarantees that the tube bend to be formed is 25 acted on with the requisite axial force without a buckling movement of the tube bend, in particular in the region of the bending plane or of the bend plane, taking place. The minimal degree of forming of the tube bend in the bending plane or bend plane guarantees that 30 the tube bend bears against the recess of the die in the region of the bend zone, so that the pushing movement of the pushing rams does not give rise to a buckling movement, in particular of the tube bend inner side. In the case of internal high-pressure forming as 35 known in the prior art, the inner side of the bend

zone, that is the side with the smaller bending radius, would be upset owing to the pressure action alone as the shaped geometry provides for a smaller radius of curvature than the blank. Superimposing the axial 5 pushing movement of the pushing rams necessary in places on this material upsetting leads to failure of the material wall. This is prevented by the tube bend which bears against the die in the bend zone, the bend being pressed against the die wall on account of the 10 pressure action without upsetting forming having been carried out beforehand.

~~According to a development, an~~ An additional 15 possibility is that an axis of symmetry of the bend zone extends in a bending plane and, in the region of the bending plane, the degree of expansion, as the ratio of the diameter of the component in the bending plane to the diameter of the blank, in the bending 20 plane, is between 1 and 1.1. The blank is consequently formed only slightly.

It is furthermore advantageous if the degree of expansion in the region normal to the bending plane is between 1 and 2, in particular between 1.3 and 1.5. In 25 this connection, it is advantageous if the degree of forming increases proportionally starting from the bending plane and reaches its maximum value toward the normal.

30 For this, it is also advantageous if a number of bend zones and a number of bending planes are provided. In the manufacture of more complex tube bend shapes, a number of bend zones can be provided, each bend zone having its own bending plane. The changing cross- 35 sectional shaping is then adapted according to the

course of the bending planes, which guarantees the bearing according to the invention of each bend zone in the region of the respective bending plane.

- 5 According to a preferred embodiment of the solution according to the invention, provision is lastly made that a transition of the cross-sectional shape from each outlet zone to the bend zone extends continuously. The continuous cross-sectional adaptation between the
10 cross-sectional shape of the outlet zones and the cross-sectional shape of the bend zone guarantees minimal flow loss of the media flowing in the tube bend.
- 15 It is of particular importance for the present invention that the cross-sectional shape of the bend zone and/or of the outlet zones is of round, oval, rectangular or polygonal design.
- 20 In connection with the design and arrangement according to the invention, it is advantageous if a tube piece blank with a diameter A is placed into the recess of the die of the internal high-pressure tool and is acted on by the pushing rams. The tube piece blank is formed
25 or expanded to a desired diameter B in the region of the outlet zones, the tube piece blank being formed or expanded to a desired diameter C in the direction parallel to the bending plane in the region of the bend zone, and the tube piece blank being formed to a
30 desired diameter D in the direction at right angles to the bending plane in the region of the bend zone. The degree of expansion as the ratio of C to A is set between 1 and 1.1. Depending on material and material thickness, a greater degree of expansion, that is
35 greater forming, is possible within the bending plane

in the region of the critical bend zone without a buckling movement occurring. In this connection, the workpiece can already bear against the die with the inner wall part, that is with the wall part with the 5 smallest bending radius, in the region of the critical bend zone before the ~~forming process, the process.~~ The minimal forming [[being]] is generated in the bending plane, in particular in the wall region with the largest bending radius, that is the outer wall region. 10 The critical buckling movement in the inner wall region is consequently prevented. Larger forming operations with a degree of forming appreciably greater than 1.1 (with regard to the ratio of deformed size to blank size) cannot, however, be realized within the bending 15 plane. In the dimensioning of the degree of expansion, the elastic yield point of the material is also to be taken into account, so that in particular the ratio of C to A can rise above 1.1 and the bearing of the elastically expanded bend zone against the die is 20 nevertheless guaranteed.

It is furthermore advantageous if the degree of expansion as the ratio of D to A is set between 1 and 2, in particular between 1.3 and 1.5. In this connection, a 25 degree of forming of 2, that is a twofold enlargement of the internal high-pressure formed part starting from the blank size, represents for the usual materials a maximum value which, depending on cross-sectional shape change, must be reached to guarantee a constant flow cross section.

30 Further advantages and details of the invention are ~~explained in~~ defined by the patent claims, ~~explained~~ explained [[and]] in the description, and illustrated in the figures, ~~in which~~.

BRIEF DESCRIPTION OF THE DRAWINGS

[[Fig.]] Figure 1 shows a longitudinal sectional illustration of a tube piece blank in the die;
5 [[Fig.]] Figure 1b [[shows]] is a view along the cross section C-C;
[[Fig.]] Figure 2 [[shows]] is a longitudinal sectional illustration of an expanded tube piece in the die, and
10 [[Fig.]] Figure 2b [[shows]] is a view along the cross section D-D.

DETAILED DESCRIPTION OF THE INVENTION

A tube bend blank 1 designed as a tube piece blank and illustrated in Figure 1 has an axis of symmetry 1.6 and a diameter A which is constant along the axis of symmetry 1.6. In this connection, the tube bend blank 1 is bent by 90° starting from a cylindrical basic shape and has an axis of symmetry 1.6 which is correspondingly curved by 90°. ~~In this connection, the~~
20 ~~The~~ radius of curvature of the axis of symmetry 1.6 is approximately 1.5 times the diameter A.

The tube bend blank 1 thus formed has a bend zone 1.1 in the region of the curvature and a first cylindrical outlet zone 1.2 and a second cylindrical outlet zone 1.3. At the end of the two outlet zones 1.2, 1.3, the tube bend blank 1 comprises a first end side 1.2' and a second end side 1.3', to which pushing rams 2, 3 of an internal high-pressure forming device are connected, which on the one hand serve for axial pressure action and on the other hand introduce the pressure medium. The tube bend blank 1 is arranged within a die 4 which comprises a recess 4.5 for receiving the tube bend blank 1. The tube bend blank 1 is coupled to the

pushing rams 2, 3 at its two end sides 1.2', 1.3'. In addition to the recess 4.5, the die 4 comprises a further recess 6 which adjoins the recess 4.5 radially and, according to Figure 2, guarantees a special 5 shaping geometry of the tube bend blank 1.

In the region of the bend zone 4.1, the recess 4.5 has in the bending plane or bend plane the same diameter A as the tube bend blank 1. According to the cross- 10 sectional illustration C-C, the recess 4.5 of the die 4 has an appreciably larger diameter D (according to section D-D) in the direction perpendicular to the bending plane or bend plane.

15 In the region of the two outlet zones 4.2, 4.3, the recess 4.5 of the die has, differing from the bend zone 4.1, a cylindrical basic shape (not illustrated further) corresponding to the tube bend blank 1. In the region of the two outlet zones 4.2, 4.3, the recess 4.5 20 has a larger diameter B (according to Figure 2) than the tube bend blank 1. Consequently, the tube bend blank 1 bears linearly with the bend zone 1.1 against the die 4 or its bend zone 4.1 in the bending zone next to the two pushing rams 2, 3.

25 In this connection, the cross-sectional shape of the recess 4.5, which is circular in the region of the two outlet zones 4.2, 4.3, changes in the region of the bend zone 4.1 according to Figure 1b to an oval cross- 30 sectional shape with the same cross-sectional area 4.4.

According to Figure 2, the tube bend blank 1 is shaped into the tube bend and has the shape of the recess 4.5. In addition to the additional radial shaping 5 in the 35 region of the second recess 6 of the die 4, the tube

bend blank 1 has in the region of the two outlet zones 1.2, 1.3 been enlarged to the diameter of the recess 4.5 and has in the region of the two outlet zones 1.2, 1.3 a corresponding circular cross-sectional shape (not 5 illustrated further). In the region of the bend zone 1.1, the tube bend blank 1 has according to Figure 2b been shaped ovally according to the oval shape of the recess 4.5, the degree of expansion being designed to be equal to 1 parallel to the bending plane and to 10 increase to a minimum dimension, that is maximum forming, in the direction at right angles to the bending plane.

During the shaping operation, the tube bend blank 1 is 15 acted on with axial pressure via the pushing rams 2, 3, with which sufficient material flow for the forming, in particular in the region of the second recess 6 or other recesses not illustrated here, is guaranteed. During the axial pressure action by the pushing rams 2, 20 3, the tube bend bears against the die 4 or its bend zone 4.1 with the bend zone 1.1 in the bending plane.